BAYOU BOEUF TMDL FOR DISSOLVED OXYGEN AND NUTRIENTS INCLUDING POINT SOURCE WASTELOAD ALLOCATIONS AND WATERSHED NONPOINT SOURCE LOAD ALLOCATIONS

SUBSEGMENT 060208

Engineering Section II
Environmental Technology Support Division
Office of Environmental Assessment
Louisiana Department of Environmental Quality

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EXECUTIVE SUMMARY

A TMDL for dissolved oxygen has been developed for Bayou Boeuf based on hydrologic and water quality data from a survey in August 1986, with some additional data from a survey in August/September 1999. Bayou Boeuf is listed on the 1998 Section 303(d) List as not meeting the water quality standard for dissolved oxygen, and ranks as a high priority (priority 1) for development of a TMDL. The Bayou Boeuf watershed is subsegment 060208 of the Vermilion Teche Basin (Basin 6). Subsegment 060208 is comprised of Bayou Boeuf and all tributaries, including the Kincaid Reservoir watershed, Flat, Middle, and Grassy Bayous, Castor Creek, the North Boeuf-Cocodrie Diversion Channel, Bayou Robert, Bayou Clear, and the Indian Creek Reservoir watershed. Bayou Lamourie and the South Boeuf-Cocodrie Diversion Channel are distributaries of Bayou Boeuf.

The current dissolved oxygen criteria for Subsegment 060208 is 5.0 mg/l year-round. Criteria of 3.5 mg/l (June–August) and 5.0 mg/l (September–May) have been proposed.

It is projected that compliance with proposed dissolved oxygen criteria will require reductions in point and non-point source loading. Urban areas discharging to Flat Bayou, North Boeuf-Cocodrie Diversion Channel, and Bayou Robert will require an 80% reduction of non-point loading. Suburban/agricultural areas discharging to upper Bayou Boeuf, Middle and Grassy Bayous, and Bayou Clear will require a 50% reduction of non-point loading. The agricultural areas draining to Bayou Boeuf below Lecompte are not projected to require a reduction in loading.

It is further projected that compliance with the existing dissolved oxygen criteria will require the elimination of all man-made non-point loading in all land use areas plus the reduction of background SOD by 0.5 gm/m^2d in the urban areas.

Point source wasteload allocations for dissolved oxygen criteria of 3.5 mg/l and 5.0 mg/l are as follows:

		Permit limitations (BOD_5/NH_3-N/DO)		Projected limits (BOD_5/NH_3-N/DO)		
Facility	Flow (mgd)	Summer*	Winter*	Summer**3.5	Summer**5.0	Winter**5.0
KOA Campground	0.011	30/-/-	---	30/--/-	30/--/-	30/--/-
Tunk's Cypress Inn	0.011	30/-/-	---	30/--/-	30/--/-	30/--/-
Woodlands Subdivision	0.017	30/-/-	---	30/--/-	30/--/-	30/--/-
Oak Shadows Subdivision	0.005	30/-/-	---	30/--/-	30/--/-	30/--/-
Cloverdale Subdivision	0.140	10/-/-	---	10/10/5	10/05/5	10/05/6
Gerard Glenn Apartments	0.006	30/-/-	---	30/--/5	30/--/5	30/--/6
Gary Glenn Apartments	0.007	30/-/-	---	30/--/5	30/--/5	30/--/6
Lynnwood Acres Subdivision	0.016	30/-/-	---	30/--/5	30/--/5	30/--/6
Timberlake VI Subdivision	0.019	30/-/-	---	30/--/-	30/--/-	30/--/-
Timberlake Subdivision	0.060	20/-/-	---	20/--/-	20/--/-	20/--/-
Grundy Cooper Subdivision	0.135	10/2/5	20/10/5	10/02/-	10/02/-	05/02/-
Lebanon Subdivision	0.036	20/-/-	---	10/05/-	10/05/-	10/02/-
Bayou Oaks Estates	0.024	30/-/-	---	30/--/-	30/--/-	30/--/-
Penny Acres Subdivision	0.038	10/2/5	20/10/5	20/--/-	20/--/-	20/--/-

* Summer months are April through October, winter months are November through March
** Summer months are June through August, winter months are September through May

There are 43 known dischargers in subsegment 060208, the majority of which (23) are too small or too far from Bayou Boeuf to have a significant impact on the model. Limits for these small facilities are generally set by state policy. Two facilities are no longer discharging. Four facilities discharge to Bayou Clear for which calibration data are not available from the 1986 survey. Bayou Clear was modeled solely for impact on Bayou Boeuf with the four facilities discharging to it at state policy limitations. Wasteload allocations were calculated for the remaining 14 dischargers based upon their expected or design discharge.

Bayou Boeuf was modeled from its headwaters (River Kilometer 167.8) to its confluence with the Boeuf-Cocodrie Diversion Channel to form Bayou Courtableau (River Kilometer 0.0). Tributaries that received one or more of the named facilities were modeled from the facility to their confluence with Bayou Boeuf. Other tributaries were modeled as point sources. Both point and nonpoint source loads were represented in the model; those nonpoint source loads including headwater loading, nonpoint loading associated with flow, benthic sediment oxygen demand and resuspension, and other nonpoint loading not associated with flow.

The flow and water quality calibrations were based on measurements taken during the 1986 and 1999 Bayou Boeuf surveys. Projections were adjusted to meet the dissolved oxygen criteria by reducing both point source and nonpoint source loading to obtain wasteload and load allocations.

Land use in the Bayou Boeuf watershed varies from urban (the city of Alexandra) in the upper watershed to agricultural (soybeans, corn, and other row crops) in the lower part of the watershed. Non-point load reduction has therefore been calculated for three categories of land use as explained above. TMDLs for the proposed and existing dissolved oxygen criteria have been calculated for Bayou Boeuf and for two tributaries as follows:

	Summer (June–August) 3.5 mg/l DO criteria	Summer (June–August) 5.0 mg/l DO criteria	Winter (September–May) 5.0 mg/l DO criteria
Bayou Boeuf			
Load allocation	15241 Kg/d	9948 Kg/d	12572 Kg/d
Point sources			
KOA Campground	5.56 Kg/d	5.56 Kg/d	5.56 Kg/d
Tunk's Cypress Inn	5.56 Kg/d	5.56 Kg/d	5.56 Kg/d
Oak Shadows Subdivision	2.53 Kg/d	2.53 Kg/d	2.53 Kg/d
Woodlands Subdivision	8.59 Kg/d	8.59 Kg/d	8.59 Kg/d
Timberlake VI Subdivision	9.60 Kg/d	9.60 Kg/d	9.60 Kg/d
Timberlake Subdivision	20.2 Kg/d	20.2 Kg/d	20.2 Kg/d
Total point source	52.1 Kg/d	52.1 Kg/d	52.1 Kg/d
Margin of Safety			
Load allocations	1693 Kg/d	1105 Kg/d	1397 Kg/d
Wasteload allocations	13.0 Kg/d	13.0 Kg/d	13.0 Kg/d
Total	1706 Kg/d	1118 Kg/d	1410 Kg/d
TMDL	16999 Kg/d	11119 Kg/d	14034 Kg/d
Flat Bayou/Middle Bayou/Grassy Bayou			
Load allocation	92.8 Kg/d	39.1 Kg/d	76.2 Kg/d
Point sources			

Cloverdale Subdivision	35.0	Kg/d	23.6	Kg/d	23.6	Kg/d
Gerard Glenn Apartments	3.03	Kg/d	3.03	Kg/d	3.03	Kg/d
Gary Glenn Apartments	3.54	Kg/d	3.54	Kg/d	3.54	Kg/d
Lynnwood Acres Subdivision	8.09	Kg/d	8.09	Kg/d	8.09	Kg/d
Total point source	49.7	Kg/d	38.3	Kg/d	38.3	Kg/d
Margin of Safety						
Load allocations	10.3	Km/d	4.35	Kg/d	8.46	Kg/d
Wasteload allocations	12.4	Km/d	9.56	Kg/d	9.56	Kg/d
Total	22.7	Kg/d	13.9	Kg/d	18.0	Kg/d
TMDL	165	Kg/d	91.3	Kg/d	132	Kg/d
North Boeuf-Cocodrie Diversion Channel						
Load allocation	980	Kg/d	625	Kg/d	750	Kg/d
Point sources						
Grundy Cooper Subdivision	16.2	Kg/d	16.2	Kg/d	10.3	Kg/d
Lebanon Subdivision	6.07	Kg/d	6.07	Kg/d	4.31	Kg/d
Bayou Oaks Estates	12.1	Kg/d	12.1	Kg/d	12.1	Kg/d
Penny Acres Subdivision	12.8	Kg/d	12.8	Kg/d	12.8	Kg/d
Total point source	47.2	Kg/d	47.2	Kg/d	39.5	Kg/d
Margin of Safety						
Load allocations	109	Kg/d	69.5	Kg/d	83.3	Kg/d
Wasteload allocations	11.8	Kg/d	11.8	Kg/d	9.88	Kg/d
Total	120	Kg/d	81.3	Kg/d	93.2	Kg/d
TMDL	1148	Kg/d	754	Kg/d	882	Kg/d

A breakdown of the TMDLs into carbonaceous biochemical oxygen demand, nitrogenous biochemical oxygen demand, and sediment oxygen demand can be found in Appendix D.

This waterbody was also listed as impaired due to nutrients. This TMDL establishes load limitations for oxygen-demanding substances and goals for reduction of those pollutants. LDEQ's position, as supported by the ruling in the lawsuit regarding water quality criteria for nutrients (Sierra Club v. Givens, 710 So.2d 249 (La. App. 1st Cir. 1997), writ denied, 705 So.2d 1106 (La. 1998), is that when oxygen-demanding substances are controlled and limited in order to ensure that the dissolved oxygen criterion is supported, nutrients are also controlled and limited. The implementation of this TMDL through wastewater discharge permits and implementation of best management practices to control and reduce runoff of soil and oxygen-demanding pollutants from nonpoint sources in the watershed will also control and reduce the nutrient loading from those sources.

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1. Introduction

Bayou Boeuf, Subsegment 060208 of the Vermilion-Teche Basin, was listed on the 1998 303(d) list as being impaired due to organic enrichment/low DO and requiring the development of a total maximum daily load (TMDL) for dissolved oxygen. It was ranked as a high priority (priority 1) for development of a TMDL. A calibrated water quality model of Bayou Boeuf and several tributaries was developed and projections run to quantify the point source wasteload allocations and nonpoint source load allocations required to meet established dissolved oxygen criteria.

This waterbody was also listed as impaired due to nutrients. This TMDL establishes load limitations for oxygen-demanding substances and goals for reduction of those pollutants. LDEQ's position, as supported by the ruling in the lawsuit regarding water quality criteria for nutrients (Sierra Club v. Givens, 710 So.2d 249 (La. App. 1st Cir. 1997), writ denied, 705 So.2d 1106 (La. 1998), is that when oxygen-demanding substances are controlled and limited in order to ensure that the dissolved oxygen criterion is supported, nutrients are also controlled and limited. The implementation of this TMDL through wastewater discharge permits and implementation of best management practices to control and reduce runoff of soil and oxygen-demanding pollutants from nonpoint sources in the watershed will also control and reduce the nutrient loading from those sources.

This report presents the development of the dissolved oxygen model and the resulting load and wasteload allocations.

1.1 Seasonality and Margin of Safety

The Clean Water Act requires the consideration of seasonal variation of conditions affecting the constituent of concern, and the inclusion of a margin of safety (MOS) in the development of a TMDL. Long-term data from six stations on the LDEQ Ambient Monitoring Network were analyzed for the relationship between dissolved oxygen, run-off, and stream temperature to provide information on critical conditions for Louisiana streams. The Louisiana Office of State Climatology water budget was used with rainfall data from that Office to calculate run-off. Since nonpoint loading is conveyed by run-off, this seemed a reasonable variable to use to represent the conveyance of non-point loading to the stream. Graphical and regression techniques were used to evaluate the relationship between stream temperature, dissolved oxygen, and run-off. It was found that temperature is strongly inversely proportional to dissolved oxygen and moderately inversely proportional to run-off. Dissolved oxygen and run-off are moderately directly proportional. It was concluded from the analysis that critical conditions for stream dissolved oxygen concentrations are those of negligible nonpoint run-off and low stream flow combined with high stream temperature.

When the rainfall run-off (and nonpoint loading) and stream flow are high, turbulence is higher due to the higher flow and the temperature is lowered by the run-off. In addition, run-off coefficients are higher in cooler weather due to reduced evaporation and evapotranspiration, so that the high flow periods of the year tend to be the cooler periods. Reaeration rates are, of course, much higher when water temperatures are cooler, and BOD decay rates are much lower. For these reasons, periods of high loading are periods of higher reaeration and dissolved oxygen but not necessarily periods of high BOD decay. LDEQ interprets this phenomenon in its TMDL modeling by assuming that the annual nonpoint loading, rather than loading for any particular day, is responsible for the accumulated benthic blanket of the stream, which is, in turn, expressed as SOD and/or resuspended BOD in the model. This accumulated loading has its greatest impact on the stream during periods of higher temperature and lower flow.

For the Bayou Boeuf TMDL, LDEQ has employed an analysis of long-term ambient data to determine critical seasonal conditions and used a combination of implied and explicit margins of safety. LDEQ simulated critical summer (June – August) conditions for the Bayou Boeuf dissolved oxygen TMDL projections by using the annual 7Q10 flow for headwaters and for tributaries being represented as point sources. Where there is no 7Q10 flow, 0.01 cfs was used for headwater flow in small tributaries and 0.1 cfs was used in larger tributaries to keep the model from crashing. The 90th percentile summer season temperature was used.

The combined 7Q10 flow for the Bayou Boeuf and Bayou Cocodrie watersheds exceeded the 7Q10 flow in Bayou Courtableau. It was assumed that agricultural withdrawal for irrigation is responsible for the difference, and incremental outflow in the agricultural reaches of Bayou Boeuf was used to balance the 7Q10s. Model loading was from point sources, perennial tributaries, sediment oxygen demand, and resuspension of sediments.

LDEQ simulated critical winter (September – May) conditions by using the lowest monthly 7Q10 flow for the perennial tributaries. Since September and October are the among the lowest flow months of the year, ditches and tributaries having no 7Q10 flow were given the same default flow used for the summer critical simulation. The 90th percentile winter season temperature was used. Again, the combined 7Q10 flow for the Bayou Boeuf and Bayou Cocodrie watersheds exceeded the 7Q10 flow in Bayou Courtableau, and incremental outflow in the agricultural reaches of Bayou Boeuf was used to balance the 7Q10s. Model loading was from point sources, perennial tributaries, sediment oxygen demand, and resuspension of sediments. LDEQ assumes that all point sources are discharging at maximum capacity.

In reality, the highest temperatures occur in July-August, the lowest stream flows occur in September-November, and the maximum point source discharge occurs following a significant rainfall, i.e., high-flow conditions. The combination of these conditions plus the impact of other conservative assumptions regarding rates and loadings yields an implied margin of safety which is estimated to be in excess of 10%. Over and above this implied margin of safety, LDEQ used an explicit MOS of 20% for point and 10% for nonpoint loads. The total MOS is estimated to exceed 20% for the Bayou Boeuf TMDL.

2. Study Area Description

2.1 Bayou Boeuf Watershed, Segment 060208

The Bayou Boeuf watershed, Subsegment 060208, is located within basin/segment 0602 in south central Louisiana. Bayou Boeuf flows in a generally southerly direction, to a confluence with Bayou Cocodrie, forming the headwaters of Bayou Courtableau. Most of the area of the Bayou Boeuf watershed lies within the natural flood plain of the Red River. The Red is now leveed, eliminating the potential for a natural flow of water from the River into any of the streams in Segment 0602.

Land use is predominately forest and agriculture with the Alexandria urban area to the north. Suburban communities have invaded the agricultural lands immediately south and west of Alexandria. The major land uses are listed in Table 1 and a very informative land use map may be found in Appendix A.

The study area is extremely flat. Elevation of the Bayou Boeuf headwaters is less than 100 feet, dropping to approximately 30 feet at the confluence with Bayou Cocodrie, 108 miles downstream. This is a slope of 0.00012. Such small slopes result in extremely low velocities at low flow conditions. Within Segment 0602, Castor Creek, Bayou Clear, and the headwaters of Kincaid and Indian Creek Reservoirs are an exception to this flow characterization. These watersheds extend into the hills of the Kisatchie National Forest along the western boundary of the Subsegment. These hills have peak elevations of 200 to 250 feet. No significant point sources are located in the upland portion of these watersheds.

The channel structure and flows within the Bayou Boeuf system have been significantly altered from their natural conditions. Bayou Boeuf flow has been diverted to the Bayou Clear Diversion Channel at RKm 140.53, rejoining the natural Bayou Boeuf channel at RKm 135.04. Some of the flow in the main channel is diverted to Bayou Lamourie at a control structure located on the natural channel upstream of the point where the Bayou Clear Diversion Channel rejoins Bayou Boeuf. Another control structure and diversion is located at RKm 124.38, this time to the South Boeuf-Cocodrie Diversion Channel. This diversion flows southward to a confluence with Bayou Cocodrie, which rejoins Bayou Boeuf to form Bayou Courtableau.

Table 1. Land uses in Segment 0602 of the Vermilion-Teche Basin

Land use	Acres	%
Urban	598	3.7
Agricultural	6,464	40.4
Upland Forest & Scrub	5,499	34.4
Wetland	2,638	16.5
Forest & Scrub	2,615	
Marsh	23	
Water	765	4.8
Barren	26	0.2
Total	15,990	

2.2 Water Quality Standards

Water quality standards for the State of Louisiana have been defined (Louisiana Department of Environmental Quality, Environmental Regulatory Code, Part IX, Water Quality Regulations, Chapter 11, 1998). These include both general narrative standards and numerical criteria. General standards include prevention of objectionable color, taste and odor, solids, toxics, oil and grease, foam, and nutrient conditions as well as aesthetic degradation.

Designated uses for Bayou Boeuf from its headwaters to confluence with Bayou Cocodrie (waterbody subsegment 060208) include primary contact recreation, secondary contact recreation, and propagation of fish and wildlife.

Bayou Boeuf Brule is listed on the 1998 303(d) List as a waterbody requiring a dissolved oxygen TMDL. Section 303(d) of the Clean Water Act requires the identification, listing, ranking and development of TMDLs for waters that do not meet applicable water quality standards after implementation of technology-based controls. Current and proposed dissolved oxygen criteria are shown in Table 2. The proposed criteria have not yet been approved.

Table 2. Dissolved Oxygen Criteria

Current:	
Year-round	5.0 mg/L
Proposed:	
June – August	3.5 mg/l
September – May	5.0 mg/l

2.3 Discharger Inventory

There are 43 known dischargers in subsegment 060208, the majority of which (23) are too small or too far from Bayou Boeuf to have a significant impact on the model. These small facilities are not distinguishable from the background of nonpoint loading. Limits for these small facilities are generally set by state policy. Two facilities are no longer discharging. Four facilities discharge to Bayou Clear for which calibration data are not available from the 1986 survey. Bayou Clear was modeled solely for impact on Bayou Boeuf with the four facilities discharging to it at state policy limitations. Wasteload allocations were calculated for the remaining 14 dischargers based upon their expected or design discharge. Table 3 is a listing of the significant dischargers.

Table 3. List of Facilities

Facility	Permit No.	Receiving Water	Design Flow (mgd)	Treatment	Permit Limits (CBOD/NH3N/DO)	Comments
KOA Campground	LAG540039	Bayou Boeuf	.011	3 cell OP	30/--/--	Not in 1986 calibration
Tunk's Cypress Inn	LAG540853	Bayou Boeuf	.011	1 cell OP	30/--/--	Not in 1986 calibration
Oak Shadows Subdivision	LAG540068	Bayou Boeuf	.005	ext-aer	30/--/--	
Woodlands Subdivision	LAG540803	Bayou Boeuf	.017	ext-aer	30/--/--	
Cloverdale Subdivision	LA0039021	Flat Bayou	.140	ext-aer/tert filt	10/--/--	
Gerard Glenn Apartments	LAG540322	Flat Bayou	.006	2 cell OP	30/--/--	
Gary Glenn Apartments	LAG540032 0	Flat Bayou	.007	3 cell OP	30/--/--	Not in 1986 calibration

Lynnwood Acres Subdivision	LAG540601	Flat Bayou	.016	3 cell OP	30/--/--	
Timberlake Subdivision	LAG540883	Bayou Boeuf	.019	ext-aer	20/10/05	Not in 1986 calibration
Timberlake VI Subdivision	LA0083763	Bayou Boeuf	.060	3 cell OP	30/--/--	Not in 1986 calibration
Grundy-Cooper Subdivision	LA0039012	N. Boeuf-Cocodrie Diversion Channel	.135	ext-aer	10/2/5 Ap-Oct 20/10/5 Nov-Mar	
Lebanon Subdivision	LA0038997	N. Boeuf-Cocodrie Diversion Channel	.036	ext-aer	20/--/--	
Twin Bridges MHP	LAG540748	Turkey Bayou	.020	3 cell OP	---	No longer discharging
Bayou Oaks Est. Subdivision	LAG540605	Turkey Bayou	.024	ext-aer	30/--/--	
Penny Acres Subdivision	LA0038989	N. Boeuf-Cocodrie Diversion Channel	.038	1 cell OP	10/2/5 Ap-Oct 20/10/5 Nov-Mar	
Westgate Village Subdivision	LAG540667	Little Bayou Clear	.011	1 cell OP	30/--/--	
Brookwood Subdivision	LAG540668	Little Bayou Clear	.066	2 cell OP	30/--/--	
Spring Creek Apartments	LAG530648	Little Bayou Clear	.004	ext-aer	45/--/--	
United Methodist Center	LA0101486	Little Bayou Clear	.087	ext-aer	10/2/5 Ap-Oct 20/10/5 Nov-Mar	Not in 1986 calibration
Willow Creek Apartments	LA0099015	Bayou Robert	.054	ext-aer	no permit	
Deerfield Subdivision	LA0072541	Bayou Robert	.078	ext-aer	10/2/5 Ap-Oct 20/10/5 Nov-Mar	No longer discharging

2.5 Previous Studies and Other Data

Water quality data for this TMDL was obtained from surveys of Bayou Boeuf conducted on August 18, 1986 and August 31 – September 2, 1999.

3. Model Documentation

3.1 Program Description

The modeling system used to simulate the Bayou Plaquemine Brule stream network was LAQUAL, a steady-state one-dimensional water quality model originally developed as QUAL-TX by the Water Quality Standards and Evaluation Section of the Texas Water Commission, and modified by the Louisiana Department of Environmental Quality. These programs are modified versions of QUAL-II, incorporating modifications that Texas and Louisiana felt necessary for modeling Texas and Louisiana streams, including the Texas and Louisiana reaeration equations, a variable element size, and coding that allows multiple models to be linked so that they can be executed in a single run. The LAQUAL model is a windows program.

3.2 Model Schematic and Description

The Bayou Boeuf system was modeled according to the vector diagram of Figure 2. The vector diagram can also be found in Appendix A with digital maps of the Bayou Boeuf watershed. The digital maps show the streams, roads, survey sites, and dischargers. Bayou Boeuf was modeled from its headwaters (River Kilometer 167.8) to its confluence with the Boeuf-Cocodrie Diversion Channel to form Bayou Courtableau (River Kilometer 0.0). Eighteen permitted dischargers were included in the system, and the four tributaries receiving those discharges were simulated by the model. Four perennial tributaries, Kincaid Reservoir, Castor Creek, Bayou Clear, and Indian Creek Reservoir were simulated as point source inputs.

The Deerfield Subdivision treatment facility was discharging to Bayou Robert at the time of the 1986 survey but Deerfield has since been taken into a regional Alexandria collection system. This discharge is included in the model calibration but is not included in the projections. During an August, 1999, reconnaissance survey Turkey Bayou was found to be dry downstream of Twin Bridges Mobile Home Park, and this facility which is also in the model calibration is not included in the projections. During both the August, 1999, reconnaissance and the August-September, 1999, survey, Bayou Robert was not flowing to Bayou Boeuf. Bayou Robert and the Willow Creek Apartment treatment facility that are simulated in the calibration have therefore been taken out of the projections.

Five facilities that were not in the calibration have been added to the projection. The KOA Campground and Tunk's Cypress Inn discharge to an upstream reach of Bayou Boeuf for which no calibration data were obtained. It was felt, however, that they could reasonably be added to the projections. Timberlake Subdivision and Timberlake VI have apparently come on line since 1986 and have been added to the projection model. The Methodist Center is also a new discharger and has been added for the projections.

The 1986 survey did not provide calibration data for Bayou Clear, and that portion of the model is therefore uncalibrated. No wasteload allocations were calculated for facilities discharging to Bayou Clear. Discharges to Bayou Clear were input to the uncalibrated model at state policy limitations.

The flow routing described in Section 2.1 has been followed in setting up the model. Zero flow was observed in Bayou Boeuf at Highway 3265. It appears that 100 percent of the flow in Bayou Boeuf diverts to the Bayou Clear Diversion Channel and that the outflow to Bayou Lamourie may cause reverse flow in Bayou Boeuf between Bayou Lamourie and confluence with Bayou Clear Diversion Channel at RKm 135. Although we cannot confirm this, the model was set up to reflect zero flow at Highway 3265, and the Bayou Lamourie withdrawal is taken out of Bayou Boeuf at RKm 135.

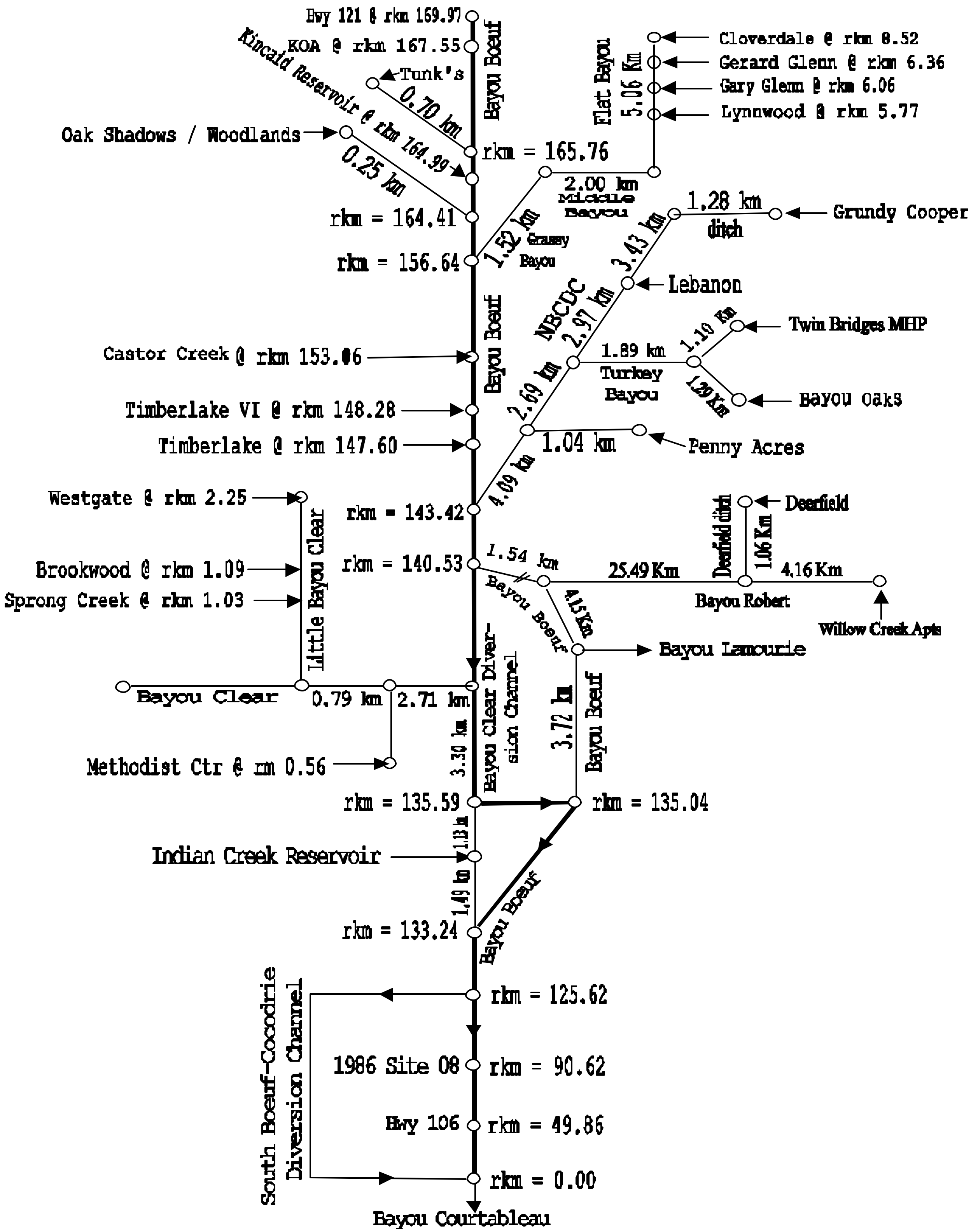

Figure 1. Vector Diagram of the Bayou Boeuf Watershed

3.3 Stream Geometry

The stream average depths and stream widths used in LAQUAL were input in one of several ways, depending on the characteristics of the reach. (1) Data for eight small free-flowing streams was analyzed to produce constants for the LAQUAL geometric equations, and these equations were used to characterize the smaller streams in the watershed; calibration reaches 1, 3, 6, 19, 20, 21, 22, and projection reaches 1, 3, 4, 6, 9, 22, 23, 24, 25, 26. Depth and width plots can be found in Appendix B. (2) Data from Big Colewa Bayou near Oak Grove was analyzed to obtain geometric equation constants and these constants were used in conjunction with survey data for the larger cross-sections to obtain geometric equation constants for calibration reaches 7, 17, 28, 29, 30, 31, 32, 33, and projection reaches 10, 20, 31, 32, 33, 34, 35, 36. Depth and width plots can be found in Appendix B. (3) Constant geometry was assumed for all ditches; calibration reaches 2, 9, 11, 12, 13, 15, 26, and projection reaches 2, 5, 12, 14, 15, 16, 18, 29. (4) Other reaches were judged to have constant geometry, and depths and widths were assigned based on survey data.

3.4 Calibration

The various spreadsheets that were used to prepare data for modeling may be found in Appendix C in the order in which they were used and are described below.

1. Summary of Survey Data

   The first two sheets contain hydrologic and water quality survey data from the 1986 and 1999 surveys

2. Reaches and Elements and Geometry

   The third sheet lists all the reaches and elements. The electronic version is automated to calculate starting and ending element numbers for the reaches to make setting up the reaches easier. Constants for the stream geometry equations are also listed here.

3. Calibration Data

   Calibration data was obtained from eight 1986 survey sites and one 1999 survey site. The 1999 data proved unusable because of the difference in flow between the 1986 and 1999 surveys. This data was entered into the “opdata” files of the model.

4. Point Sources

   All point sources are listed, both treatment facilities and perennial tributaries that are not modeled. The electronic version is automated to calculate the input element for some of the inputs.

5. Inputs

   Inputs consist of all headwaters, point sources, and distributaries. The input data necessary for the model is listed. Distributary flows were measured during the 1986 survey. Castor Creek and Indian Creek Reservoir flows were obtained by calibration. Headwater flows were set to a nominal 0.01 cfs for small headwaters and 0.1 cfs for larger headwaters to keep the model from crashing. Facility flows were input at the design flow based on Department of Health criteria. Water quality for the Bayou Boeuf and Bayou Clear headwaters, and for Castor Creek was measured. Since the Bayou Boeuf headwater flow comes from Kincaid Reservoir, and Indian Creek Reservoir has a similar watershed in the Kisatchie National Forest, Bayou Boeuf data was used for the Indian Creek Reservoir outlet. An assumed water quality was used for the minimum flow headwaters since they have almost no impact on the model. The water quality of some dischargers was measured during the 1986 survey. The rest of the dischargers were input at a water quality based on the type of treatment.

6. Initial Conditions

   Initial conditions govern the value of those variables that are not modeled and provide a starting point for iteration for those that are modeled. Temperature and *Chlorophyll a* are not modeled and input values are taken from survey data. *Chlorophyll a* is used to simulate algae oxygen production in the calibration runs. Dissolved oxygen is input at 3.0 as a starting point for iteration.

7. Coefficients

   Rate coefficients are input as uniform values for each reach. The Louisiana reaeration equation was selected throughout. It is the only equation which is appropriate for the shallow, low-velocity, reaches. Owens is more appropriate for the deeper reaches but at low velocities and shallow depths, where the Louisiana Equation and Owens overlap, the two equations produce very different results; the result from Owens is sometimes half and sometimes more than double the result from the Louisiana equation. Since only 7 of the reaches have velocities within the range of Owens while 18 reaches are within the velocity range of the Louisiana Equation, it was decided to stick with the Louisiana Equation for all reaches. The 15 reaches out of range for the Louisiana Equation can only be covered by the “mini K_L”, but since the Louisiana Equation defaults to the mini K_L at low velocities, it is useable in this range.

   Since most of the stream distance is unimpacted by treatment facilities, CBOD and NBOD settling rates are input at a level typical of background. Higher settling rates would accomplish nothing since they would only require higher nonpoint loading to calibrate. CBOD and NBOD decay rates are input at the appropriate survey sample bottle rates. SOD is established by calibration.

8. Incremental Inflow

   Incremental inflow to upper Bayou Boeuf was determined by flow calibration of Bayou Boeuf from the headwaters to Highway 488 including inflow to Flat/Middle/Grassy Bayous. Incremental inflow to the rest of Bayou Boeuf was determined by flow calibration of Bayou Boeuf from Highway 165 to Bayou Clear Diversion Channel at Highway 3265. This inflow was used for all other tributaries except ditches, which were input with zero incremental inflow.

9. Nonpoint Loading

   Nonpoint loading was determined by calibration as Kg/reach-day. The spreadsheet converts these numbers to gm/m^{2}d for later use in totaling benthic loading.

3.5 Projections

As previously discussed, Bayou Robert was effectively taken out of the projection by inputing only a nominal 0.1 cfs headwater flow. No point source or incremental flows to Bayou Robert were simulated. Twin Bridges Mobile Home was also removed from the projections. Three reaches were added to the top of the model to accommodate the addition of new dischargers. As previously discussed, five dischargers that were not in the calibration are simulated by the projection runs.

1. 7Q10 of Perennial Streams

   The U.S. Geological Survey has determined the 7Q10 of several branches of Castor Creek (Loving Creek, Long Branch, and Castor Creek at Castor Plunge Road) by correlation with Big Creek at Pollock. We have used the average of the flow to drainage area ratios of these streams to estimate 7Q10 flow for the four perennial tributaries to Bayou Boeuf. Two of these tributaries are reservoirs and the 7Q10 flow has been adjusted for reservoir surface evaporation. The winter 7Q10 flows have been estimated by applying the winter to annual 7Q10 ratio for Big Creek. Note that since the winter season has been defined by DEQ as September through May, the winter to annual 7Q10 ratio is unusually low and the winter season 7Q10 flows are therefore also quite low.

2. SWQMN Field Data

   Critical temperature has been calculated from the last 10 years of data from the SWQMN site on Bayou Boeuf near Milburn. The 90 percentile summer and winter season temperatures are 28.2^{o}C and 23.0^{o}C respectively. The seasons defined by DEQ have resulted in high estimates for both the summer and winter critical temperature.

3. Reaches and Elements and Geometry

   This sheet lists all the reaches and elements. The electronic version is automated to calculate starting and ending element numbers for the reaches to make setting up the reaches easier. Constants for the stream geometry equations are also listed here.

4. Summer and Winter Headwater and Point Source Inputs

   Inputs consist of all headwaters, point sources, and distributaries except for treatment facilities. The input data necessary for the model is listed. The Bayou Lamourie outflow was measured during the 1986 survey. South Boeuf-Cocodrie Diversion Channel outflow was obtained from the FTN Associates Bayou Cocodrie TMDL. Kincaid Reservoir, Castor Creek, Bayou Clear headwater, and Indian Creek Reservoir flows were set at the appropriate 7Q10 value. Other headwater flows were set to a nominal 0.01 cfs for small headwaters and 0.1 cfs for larger headwaters to keep the model from crashing. Water quality, including dissolved oxygen, for the Bayou Clear headwaters, and for Castor Creek and Kincaid Reservoir was measured during the 1999 survey. Since Indian Creek Reservoir has a similar watershed in the Kisatchie National Forest, water quality data from Kincaid Reservoir outlet was used. Water quality for the headwaters of Little Bayou Clear and Methodist Creek was obtained from the Bayou Clear headwater site of the 1999 survey, except that 90% saturation dissolved oxygen was used. Other headwaters are input at minimum flow and a nominal assumed water quality, including 90% dissolved oxygen saturation.

5. Facility Inputs

   Facilities were input at 125% of design flow by Department of Health criteria. Concentrations of CBOD, NBOD, and DO were adjusted to meet dissolved oxygen criteria.

6. Flow Balance

   The FTN Associates Bayou Cocodrie TMDL 7Q10 flows and the Bayou Boeuf TMDL 7Q10 flows add to the 7Q10 flows in Bayou Courtableau at Washington. In order to accomplish this a small quantity of incremental outflow in the lower (agricultural) reaches of Bayou Boeuf was needed. This outflow probably reflects periodic withdrawals for irrigation.

7. Point Sources

   All point source inputs are listed and the spreadsheet partially automated to calculate the appropriate model element for input.

8. Initial Conditions

   Initial conditions govern the value of those variables that are not modeled and provide a starting point for iteration for those that are modeled. Temperature is not modeled and input values are the 90 percentile seasonal temperatures.. *Chlorophyll a*, which is used to simulate algae oxygen production in the calibration runs, is input at zero, that is, no production of oxygen due to algae is assumed. Dissolved oxygen is input at 3.0 as a starting point for iteration.

9. Summer Coefficients

   Rate coefficients are kept at the calibration level except for SOD. The projection SOD levels are documented in the Benthic Input spreadsheets.

10. Winter Coefficients

    Rate coefficients are kept at the calibration level except for SOD. The projection SOD levels are documented in the Benthic Input spreadsheets.

11. Summer Incremental Inflow

    As explained in the Flow Balance section, projection item 6, the only incremental flow is an outflow from the lower reaches of Bayou Boeuf.

12. Winter Incremental Inflow

    As explained in the Flow Balance section, projection item 6, the only incremental flow is an outflow from the lower reaches of Bayou Boeuf.

13. Benthic Input for Summer DO Criteria of 3.5

    The desired percent reduction of manmade nonpoint benthic load (from calibration levels) is entered in the appropriate column, and the spreadsheet calculates the appropriate input levels of SOD, CBOD, and NBOD. The percent reduction is adjusted in conjunction with facility effluent concentrations, in a trial and error manner, until model runs indicate that dissolved oxygen criteria will be met. Natural background levels of loading are based on sampling and modeling of “least-impacted” reference streams.

14. Benthic Input for Summer DO Criteria of 5.0

    In order to meet the present criteria of 5.0 mg/l dissolved oxygen it was necessary to eliminate all man-made nonpoint and sediment oxygen demand loading and, in addition, to further reduce SOD by 0.5 gm/m^{2}d. The loading required to meet the current criteria is therefore less than the estimated natural background. It was also necessary to tighten the effluent limitations of one point source discharger.

15. Benthic Input for 50% Nonpoint Reduction

    The percent reduction of manmade nonpoint benthic load (from calibration levels) is set at 50% for all reaches to obtain model input values of SOD, CBOD, and NBOD.

16. Benthic Input for Zero Nonpoint

    The percent reduction of manmade nonpoint benthic load (from calibration levels) is set at 100% for all reaches to obtain model input values of SOD, CBOD, and NBOD. These input levels are used for zero man-made nonpoint loading runs (with facility discharges), and for zero man-made loading runs (no facility or man-made nonpoint loading).

17. Benthic Input for Winter DO Criteria of 5.0

    The desired percent reduction of manmade nonpoint benthic load (from calibration levels) is entered in the appropriate column, and the spreadsheet calculates the appropriate input levels of SOD, CBOD, and NBOD. The percent reduction is adjusted in conjunction with facility effluent concentrations, in a trial and error manner, until model runs indicate that dissolved oxygen criteria will be met. Natural background levels of loading are based on sampling and modeling of "least-impacted" reference streams.

18. Summer TMDLs

    The summer season mass loading LAs and WLAs and TMDLs are calculated for the three waterbodies for which TMDLs and allocations can be reasonably estimated. A TMDL was not calculated for Bayou Clear because the 1986 survey did not obtain water quality or flow data for calibration of that portion of the model.

19. Winter TMDLs

    The winter season mass loading LAs and WLAs and TMDLs are calculated for the three waterbodies for which TMDLs and allocations can be reasonably estimated. A TMDL was not calculated for Bayou Clear because the 1986 survey did not obtain water quality or flow data for calibration of that portion of the model.

20. Summer Sensitivity Runs Based on Projection to Meet 3.5 DO

    Sensitivity runs were made for the summer 3.5 DO projection. In order of decreasing sensitivity, the critical parameters are reaeration, SOD, temperature, depth, flow, and CBOD decay rate.

3.6 Minimum Projection Dissolved Oxygen

Table 4 lists the minimum dissolved oxygen levels projected for each stream at summer and winter critical conditions and for the various levels of load reduction. Note that the zero man-made load runs do not achieve the current dissolved oxygen criteria of 5.0 mg/l in the North Boeuf-Cocodrie diversion Channel.

Table 4. Minimum Dissolved Oxygen Levels

Minimum Dissolved Oxygen Levels Summer And Winter Projections							
Stream	Summer Projection Concentration (mg/l)					Winter Projection Concentration (mg/l)	
	To meet 3.5 DO	To meet 5.0 DO	50% Man-made Nonpoint Reduction	100% man-made Nonpoint Reduction	No Man-made Load	To Meet 5.0 DO	No Man-made Load
Flat/Middle/Grassy Bayous	3.6	5.0	3.0	3.7	6.3	5.1	7.0
North Boeuf-Cocodrie Diversion Channel	3.5	5.0	2.5	3.4	4.2	5.1	5.6
Bayou Boeuf	3.9	5.0	4.2	5.0	5.1	5.4	6.1

3.7 Sensitivity Analysis

Sensitivity analysis was performed for the summer critical projection, with the following results:

Table 5. Summer Projection Sensitivity Analysis

To meet a DO criteria of 3.5 mg/l	Bayou Boeuf/Bayou Clear Diversion Channel		North Boeuf-Cocodrie Diversion Channel		Flat/Middle/Grassy Bayous	
	Variation of parameter					
	- 30 % or 2^{o}C	+ 30 % or 2^{o}C	- 30 % or 2^{o}C	+ 30 % or 2^{o}C	- 30 % or 2^{o}C	+ 30 % or 2^{o}C
Parameter	Percent change in minimum DO					
Reaeration	- 43.6	+ 23.1	- 44.1	+ 32.4	- 47.2	+ 25.0
SOD	+ 20.5	- 23.1	+ 28.6	- 28.6	+ 16.7	- 19.4
Temperature	+ 12.8	- 12.8	+ 17.1	- 14.3	+ 11.1	- 13.9
Depth	+ 12.8	- 10.3	+ 2.9	0.0	+ 13.9	- 11.1
Flow	- 5.1	+ 2.6	0.0	+2.9	- 2.8	0.0
K_d	+ 2.6	- 2.6	+ 2.9	0.0	+ 8.3	- 8.3
K_n	0.0	0.0	+2.9	0.0	0.0	0.0

To meet a DO criteria of 5.0 mg/l	Bayou Boeuf/Bayou Clear Diversion Channel		North Boeuf-Cocodrie Diversion Channel		Flat/Middle/Grassy Bayous	
	Variation of parameter					
	- 30 % or 2^{o}C	+ 30 % or 2^{o}C	- 30 % or 2^{o}C	+ 30 % or 2^{o}C	- 30 % or 2^{o}C	+ 30 % or 2^{o}C
Parameter	Percent change in minimum DO					
Reaeration	- 19.1	+ 11.3	- 24.0	+ 13.1	- 19.4	+ 10.1
SOD	+ 12.9	- 12.9	+ 11.9	- 11.9	+ 4.4	- 4.4
Temperature	+ 9.5	- 9.5	+ 8.7	- 8.7	+ 7.3	- 7.3
Depth	+ 6.0	- 3.8	+ 0.4	+ 0.2	+ 10.5	- 9.1
Flow	- 2.6	+ 1.6	- 0.2	+ 0.2	- 3.2	+ 2.8
K_d	+ 1.6	- 1.0	+ 1.4	- 0.6	+ 8.9	- 7.7
K_n	+ 0.2	- 0.0	+0.2	+ 0.0	+ 0.6	+ 0.0

Since reaeration and SOD are both sensitive to depth, we can say that three of the top four most sensitive parameters are depth related. It is especially important, therefore, that stream hydrologic data be reasonably good. Data from the sensitivity runs may be found in the Bayou Boeuf summer projection sensitivity spreadsheet.

4. TMDLs and Allocations

Land use in the Bayou Boeuf watershed varies from urban (the city of Alexandra) in the upper watershed to agricultural (soybeans, corn, and other row crops) in the lower part of the watershed. Non-point load reduction has therefore been calculated for three categories of land use.

It is projected that compliance with proposed dissolved oxygen criteria will require reductions in point and non-point source loading. Urban areas discharging to Flat Bayou, North Boeuf-Cocodrie Diversion Channel, and Bayou Robert will require an 80% reduction of non-point loading. Suburban/agricultural areas discharging to upper Bayou Boeuf, Middle and Grassy Bayous, and Bayou Clear will require a 50% reduction of non-point loading. The agricultural areas draining to Bayou Boeuf below Lecompte are not projected to require a reduction in loading.

It is further projected that compliance with the existing dissolved oxygen criteria will require the elimination of all man-made non-point loading in all land use areas, the reduction of background SOD by 0.5 gm/m^{2}d in the urban areas, and the tightening of summer limitations for Cloverdale subdivision. It was not possible to trade this reduction in non-point loading for any further tightening of point source limitations. A projection at zero discharge for all point sources required the elimination of all man-made non-point loading in all land use areas and the reduction of background SOD by 0.4 gm/m^{2}d in the urban areas.

Point source wasteload allocations against dissolved oxygen criteria of 3.5 (proposed) and 5.0 (existing) are as follows:

Table 6. Point Source Allocations

Facility	Flow (mgd)	Permit limitations (BOD_5/NH_3-N/DO) Summer*	Winter*	Projected limits (BOD_5/NH_3-N/DO) Summer**3.5	Summer**5.0	Winter**5.0
KOA Campground	0.011	30/-/-	---	30/--/-	30/--/-	30/--/-
Tunk's Cypress Inn	0.011	30/-/-	---	30/--/-	30/--/-	30/--/-
Woodlands Subdivision	0.017	30/-/-	---	30/--/-	30/--/-	30/--/-
Oak Shadows Subdivision	0.005	30/-/-	---	30/--/-	30/--/-	30/--/-
Cloverdale Subdivision	0.140	10/-/-	---	10/10/5	10/05/5	10/05/6
Gerard Glenn Apartments	0.006	30/-/-	---	30/--/5	30/--/5	30/--/6
Gary Glenn Apartments	0.007	30/-/-	---	30/--/5	30/--/5	30/--/6
Lynnwood Acres Subdivision	0.016	30/-/-	---	30/--/5	30/--/5	30/--/6
Timberlake VI Subdivision	0.019	30/-/-	---	30/--/-	30/--/-	30/--/-
Timberlake Subdivision	0.060	20/-/-	---	20/--/-	20/--/-	20/--/-
Grundy Cooper Subdivision	0.135	10/2/5	20/10/5	10/02/-	10/02/-	05/02/-
Lebanon Subdivision	0.036	20/-/-	---	10/05/-	10/05/-	10/02/-
Bayou Oaks Estates	0.024	30/-/-	---	30/--/-	30/--/-	30/--/-
Penny Acres Subdivision	0.038	10/2/5	20/10/5	20/--/-	20/--/-	20/--/-

* Summer months are April through October, winter months are November through March
** Summer months are June through August, winter months are September through May

TMDLs have been calculated for Bayou Boeuf and for two tributaries as follows:

Table 7. Total Maximum Daily Loads

	Summer (June–August) 3.5 mg/l DO criteria	Summer (June–August) 5.0 mg/l DO criteria	Winter (September–May) 5.0 mg/l DO criteria
Bayou Boeuf			
Load allocation	15241 Kg/d	9948 Kg/d	12572 Kg/d
Point sources			
KOA Campground	5.56 Kg/d	5.56 Kg/d	5.56 Kg/d
Tunk's Cypress Inn	5.56 Kg/d	5.56 Kg/d	5.56 Kg/d
Oak Shadows Subdivision	2.53 Kg/d	2.53 Kg/d	2.53 Kg/d
Woodlands Subdivision	8.59 Kg/d	8.59 Kg/d	8.59 Kg/d
Timberlake VI Subdivision	9.60 Kg/d	9.60 Kg/d	9.60 Kg/d
Timberlake Subdivision	20.2 Kg/d	20.2 Kg/d	20.2 Kg/d
Total point source	52.1 Kg/d	52.1 Kg/d	52.1 Kg/d
Margin of Safety			
Load allocations	1693 Kg/d	1105 Kg/d	1397 Kg/d
Wasteload allocations	13.0 Kg/d	13.0 Kg/d	13.0 Kg/d
Total	1706 Kg/d	1118 Kg/d	1410 Kg/d
TMDL	16999 Kg/d	11119 Kg/d	14034 Kg/d
Flat Bayou/Middle Bayou/Grassy Bayou			
Load allocation	92.8 Kg/d	39.1 Kg/d	76.2 Kg/d
Point sources			
Cloverdale Subdivision	35.0 Kg/d	23.6 Kg/d	23.6 Kg/d
Gerard Glenn Apartments	3.03 Kg/d	3.03 Kg/d	3.03 Kg/d
Gary Glenn Apartments	3.54 Kg/d	3.54 Kg/d	3.54 Kg/d

Lynnwood Acres Subdivision	8.09	Kg/d	8.09	Kg/d	8.09	Kg/d
Total point source	49.7	Kg/d	38.3	Kg/d	38.3	Kg/d
Margin of Safety						
Load allocations	10.3	Km/d	4.35	Kg/d	8.46	Kg/d
Wasteload allocations	12.4	Km/d	9.56	Kg/d	9.56	Kg/d
Total	22.7	Kg/d	13.9	Kg/d	18.0	Kg/d
TMDL	165	Kg/d	91.3	Kg/d	132	Kg/d
North Boeuf-Cocodrie Diversion Channel						
Load allocation	980	Kg/d	625	Kg/d	750	Kg/d
Point sources						
Grundy Cooper Subdivision	16.2	Kg/d	16.2	Kg/d	10.3	Kg/d
Lebanon Subdivision	6.07	Kg/d	6.07	Kg/d	4.31	Kg/d
Bayou Oaks Estates	12.1	Kg/d	12.1	Kg/d	12.1	Kg/d
Penny Acres Subdivision	12.8	Kg/d	12.8	Kg/d	12.8	Kg/d
Total point source	47.2	Kg/d	47.2	Kg/d	39.5	Kg/d
Margin of Safety						
Load allocations	109	Kg/d	69.5	Kg/d	83.3	Kg/d
Wasteload allocations	11.8	Kg/d	11.8	Kg/d	9.88	Kg/d
Total	120	Kg/d	81.3	Kg/d	93.2	Kg/d
TMDL	1148	Kg/d	754	Kg/d	882	Kg/d

A breakdown of the TMDLs into carbonaceous biochemical oxygen demand, nitrogenous biochemical oxygen demand, and sediment oxygen demand can be found in Appendix D.

4.1 TMDL Calculations

An outline of the TMDL calculations is provided to assist in understanding the calculations in the Appendices.

- The natural background benthic loading was estimated based on reference stream NBOD, CBOD, and SOD data. A total of SOD, CBOD, and NBOD (2 gm/m^{2}d for larger streams and 1 gm/m^{2}d for smaller streams) was arrived at rather than individual numbers for SOD, CBOD, and NBOD.
- The natural background benthic loading was divided into SOD, CBOD, and NBOD in such a way that each component was smaller than or equal to the corresponding calibration loading.
- The natural background SOD, CBOD, and NBOD were subtracted from the calibration SOD, CBOD, and NBOD to get the estimated man-made loading for each reach.
- The reaches were divided into three groups by land use, and an equal percentage reduction of man-made loading was applied to each group of reaches. For each reach the reduced man-made SOD, CBOD, and NBOD were added to the natural background SOD, CBOD, and NBOD (and CBOD and NBOD converted to units of Kg/d) to get the input loading for the model.
- Model runs were made, varying the percent reduction of man-made loading and the facility effluent concentrations such that stream dissolved oxygen criteria were met for each stream.
- Projection runs were made with:
  - Treatment facilities represented at 125% of design flow (based on Department of Health design criteria) to provide an explicit 20% margin of safety for point source loading.
  - Headwater flows at seasonal 7Q10 or 0.01 cfs (small streams) or 0.1 cfs (larger streams), whichever was greater.

- Headwater concentrations of CBOD, NBOD, and DO at calibration levels.

- The projection CBOD, NBOD, and SOD were summed and multiplied by 0.9 to get the total benthic loading in Kg/d for each reach, and by 0.1 to get the nonpoint margin of safety (a 10% explicit margin of safety was employed for non-point loading).
- The total treatment facility loading was calculated from facility design flow (based on Department of Health design criteria) and the projection CBOD and NBOD concentrations.
- The facility margin of safety was calculated as 25% of the facility loading and a total (nonpoint and facility) MOS was calculated.
- The total stream loading capacity was calculated as the sum of:
  - Headwater CBOD and NBOD loading in Kg/d.
  - Point source CBOD and NBOD loading in Kg/d.
  - Facility CBOD and NBOD loading in Kg/d.
  - Projection benthic loading for all reaches of the stream in Kg/d.
  - The total MOS

The TMDL for the Bayou Boeuf watershed was set equal to the total stream loading capacity.

5. Conclusion

Projections indicate that there is no implementation that will achieve compliance with the existing dissolved oxygen criteria of 5.0 mg/l.

LDEQ will work with other agencies such as local Soil Conservation Districts to implement agricultural and other best management practices in the watershed through the 319 programs. LDEQ will also continue to monitor the waters to determine whether standards are being attained.

In accordance with Section 106 of the federal Clean Water Act and under the authority of the Louisiana Environmental Quality Act, the LDEQ has established a comprehensive program for monitoring the quality of the state's surface waters. The LDEQ Surveillance Section collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term data base for water quality trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state's biennial 305(b) report (*Water Quality Inventory*) and the 303(d) list of impaired waters. This information is also utilized in establishing priorities for the LDEQ nonpoint source program.

The LDEQ has implemented a watershed approach to surface water quality monitoring. Through this approach, the entire state is sampled over a five-year cycle with two targeted basins sampled each year. Long-term trend monitoring sites at various locations on the larger rivers and Lake Pontchartrain are sampled throughout the five-year cycle. Sampling is conducted on a monthly basis or more frequently if necessary to yield at least 12 samples per site each year. Sampling sites are located where they are considered to be representative of the waterbody. Under the current monitoring schedule, targeted basins follow the TMDL priorities. In this manner, the first TMDLs will have been implemented by the time the first priority basins will be monitored again in the second five-year cycle. This will allow the

LDEQ to determine whether there has been any improvement in water quality following implementation of the TMDLs. As the monitoring results are evaluated at the end of each year, waterbodies may be added to or removed from the 303(d) list. The sampling schedule for the first five-year cycle is shown below.

1998 - Mermentau and Vermilion-Teche River Basins
1999 - Calcasieu and Ouachita River Basins
2000 - Barataria and Terrebonne Basins
2001 - Lake Pontchartrain Basin and Pearl River Basin
2002 - Red and Sabine River Basins

The Atchafalaya and Mississippi Rivers will be sampled continuously. The Mermentau and Vermilion-Teche Basins will be sampled again in 2003.

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LADEQ Ambient Network Database

LADEQ Assessment Network Database

Permit Tracking System (PTS)

Permit Files